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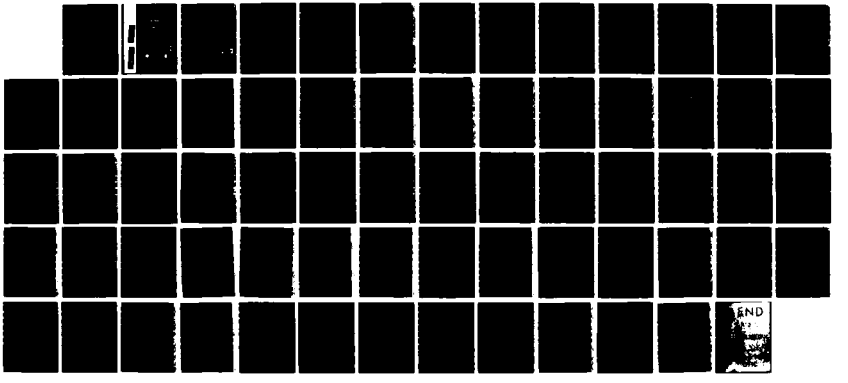

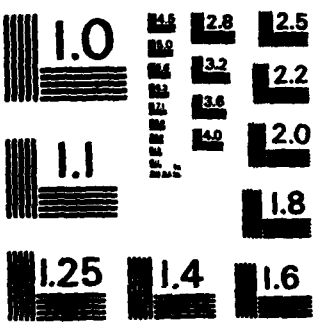

An IJC Report to the Governments of Canada and the United States

Limited Regulation of Lake Erie

INTERNATIONAL JOINT COMMISSION

Limited Regulation of Lake Erie

International Joint Commission
Canada and United States
November 1983

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EXECUTIVE SUMMARY

In February 1977, the Governments of Canada and the United States requested the International Joint Commission to determine whether limited regulation of Lake Erie water levels would be in the public interest of both countries. The request came about as a result of record high water levels on Lake Erie and Lakes Michigan and Huron in the early 1970's, and in response to the Commission's recommendation to the Governments in its 1976 report entitled *Further Regulation of the Great Lakes* for such a study. These record high water levels combined with storms resulted in extensive flood and erosion damages to shoreline properties on the lakes.

The Commission established the International Lake Erie Regulation Study Board to perform the investigations. The Board conducted studies on regulation plans and regulatory works, and evaluated their effects on shore property, hydro-electric power, the environment and recreation, and navigation. The Board also conducted a series of public meetings to present the preliminary findings and to obtain the views and comments of the public before preparing its report. Public hearings were also held by the Commission prior to and following the Board's study.

Limited regulation of Lake Erie would involve increasing its outflows during periods of high water supplies to the upper Great Lakes from which Lake Erie receives over 80 percent of its water. This would require regulatory works which would increase the outflow from Lake Erie in the Buffalo-Fort Erie area. The works would be opened during periods of high supplies and thus lower the levels of Lake Erie. During periods of low water supplies to the upper Great Lakes, the works would be operated to permit Lake Erie outflows which would have occurred had the works not been built.

Out of a number of possible Niagara regulatory works plans, three were selected for detailed analysis:

1. the modification of the existing Black Rock Navigation Lock to provide an outflow increase of about 110 cubic metres per second (4,000 cubic feet per second);

2. a diversion channel across Squaw Island equipped with a control structure to provide an outflow increase of about 280 cms (10,000 cfs); and,

3. a channel enlargement in the Niagara River together with a compensatory structure in the vicinity of the Peace Bridge to provide an outflow increase of about 710 cms (25,000 cfs).

By comparison, the long-term average Niagara River flow is about 5660 cms (200,000 cfs). Thus, these increases would represent 2 to 12 percent of the average river flow.

To mitigate adverse effects on Lake Ontario and the St. Lawrence River from Lake Erie regulation, measures consisting of changes to the present plan for regulating the outflow of Lake Ontario and channel enlargements in the international and Canadian reaches of the St. Lawrence River were examined. Channel enlargements in the Canadian reach, in the Lachine area near Montreal, Quebec, would be similar to those studied in the Canada-Quebec study of flow regulation. Such enlargements, however, would not mitigate any possible adverse effects in the Montreal area and downstream. The effects of Lake Erie regulation plans on the water levels and outflows of the Great Lakes-St. Lawrence River system were evaluated in detail by the Board. In addition, the economic impacts of regulation on the major users of the Great Lakes, which include shore property owners, hydro-electric power, navigation, and recreational beaches and boating interests were estimated. The evaluation of environmental impacts was basically qualitative, and relied heavily on existing data.

Limited regulation of Lake Erie would have the effect of lowering that lake's water levels, and to a lesser extent the levels of the lakes upstream. As a result, flood and erosion damages on those lakes would be somewhat reduced. Recreational beach interests would also experience some benefits. At the same time, however, commercial navigation, recreational boating, and hydro-electric power interests would experience losses. The effects of limited regulation of Lake Erie on the environment would be generally adverse.

The Commission's International Great Lakes Diversions and Consumptive Uses Study Board has reported that the Welland Canal diversion has been increased in recent years and that consumptive uses are forecast to increase substantially during the next 60 years. The net effect of these events does not substantially alter the results of this study.

Overall, the Commission finds that there would be economic losses far outweighing any benefits derived from limited regulation of Lake Erie as examined. The magnitude of the losses as compared to the benefits is such that no reasonable changes in assumptions or evaluative techniques could result in net benefits approaching the cost of the Niagara regulatory works.

In light of the above, the Commission recommends that:

1. No further or more detailed studies of limited Lake Erie regulation for the purpose of reducing high water levels be considered in view of the adverse impacts and the wide disparity between the costs and benefits of such regulation.

2. The Federal, State and Provincial Governments take further steps to assure that better coastal zone management practices are followed in order to reduce flood and erosion damage along the shoreline of the Great Lakes.

3. Federal, State and Provincial Governments undertake a vigorous information program to bring about a better understanding of the natural phenomena which cause the fluctuations of the levels of the Great Lakes.

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Chapter I

INTRODUCTION

General

The International Joint Commission in its 1976 report *Further Regulation of the Great Lakes*, recommended that a study be undertaken to ascertain the effects of limited regulation of Lake Erie with respect to the damage that can be alleviated, the effects on levels and flows throughout the whole Great Lakes System, the environmental impact, and the effects on shore property, navigation and power interests. The Governments of Canada and the United States responded on February 21, 1977 by requesting the Commission to undertake such a study taking into consideration the effect on the international and Canadian reaches of the St. Lawrence River, applicable Commission Orders of Approval and recommendations of the Canada-Quebec study of flow regulation in the Montreal region. The complete text of the reference is included as Appendix A. The Canada-Quebec recommendations are included as Appendix B.

This report summarizes the Board's investigations conducted in response to the request from governments, and contains the Commission's recommendations based on those investigations and public hearings held by the Commission on this subject.

Conduct of the Inquiry

The Commission established the International Lake Erie Regulation Study Board on May 3, 1977 to conduct the necessary investigations and field studies and to advise the Commission on all relevant matters. The Board consisted of eight members, four drawn from Canadian federal and provincial agencies and four from United States federal and state agencies. They were directed to act as a unitary body; to coordinate and integrate their investigations in both countries; to consider the environmental impacts of limited regulation of Lake Erie; and to make provision for public information and participation throughout the course of the study.

The Commission received a second reference on February 21, 1977 relating to effects of existing and proposed diversions within, into, or out of the Great Lakes Basin and of existing and foreseeable patterns of consumptive uses on Great Lakes water levels and flows. Copies of the two references, the directives to both Boards and their plans of study as well as background information were distributed to all known interests. Public hearings on both references were held on November 15, 16 and 17, 1977 at Chateauguay, Quebec and at Chicago and Peoria, Illinois respectively; and on December 5, 6, 7 and 8, 1977 at Cleveland, Ohio, Buffalo, New York, Windsor, Ontario and Toronto, Ontario respectively. Their purpose was to provide an opportunity for concerned interests to express views on the two references, and opinions on revisions to the two directives and plans of study.

The Board's investigation proceeded in accordance with the plan of study approved by the Commission. Funding constraints extended its duration and modified the scope and

level of detail of the environmental studies. On March 4, 1980 the Board briefed the Commission on the regulation plans developed at that time along with the results of the evaluations.

During the course of the investigation the Board submitted ten semi-annual progress reports. It maintained close liaison with the International Great Lakes Diversions and Consumptive Uses Study Board as well as with the International St. Lawrence River Board of Control. The public information program used by the Board informed all those interested of the study activities.

The Commission received the Board's main report and the eight appendices, in November 1981. After distribution of these documents the Commission held public hearings on November 17, 18 and 19, 1982, at Cleveland, Ohio, Niagara Falls, Ontario and Ogdensburg, New York, respectively. Their purpose was to receive comment on the Board's report and additional information on the subject. The testimony given at the 1977 and 1982 hearings is summarized in Chapter IV.

During its deliberations on limited regulation of Lake Erie, the Commission has considered the reports of the Board, the written and oral testimony received at its public hearings and supplementary information obtained from various sources.

The International Joint Commission wishes to acknowledge with gratitude the valuable contribution of the members of the International Lake Erie Regulation Study Board and of the members of the seven committees and two ad hoc groups which assisted the Board in its endeavours. Without their individual and collective assistance completion of the Commission's inquiry would not have been possible. The Commission also wishes to acknowledge the support and cooperation of more than twenty federal, state and provincial agencies who participated in the investigation.

CHAPTER II

EXISTING CONDITIONS

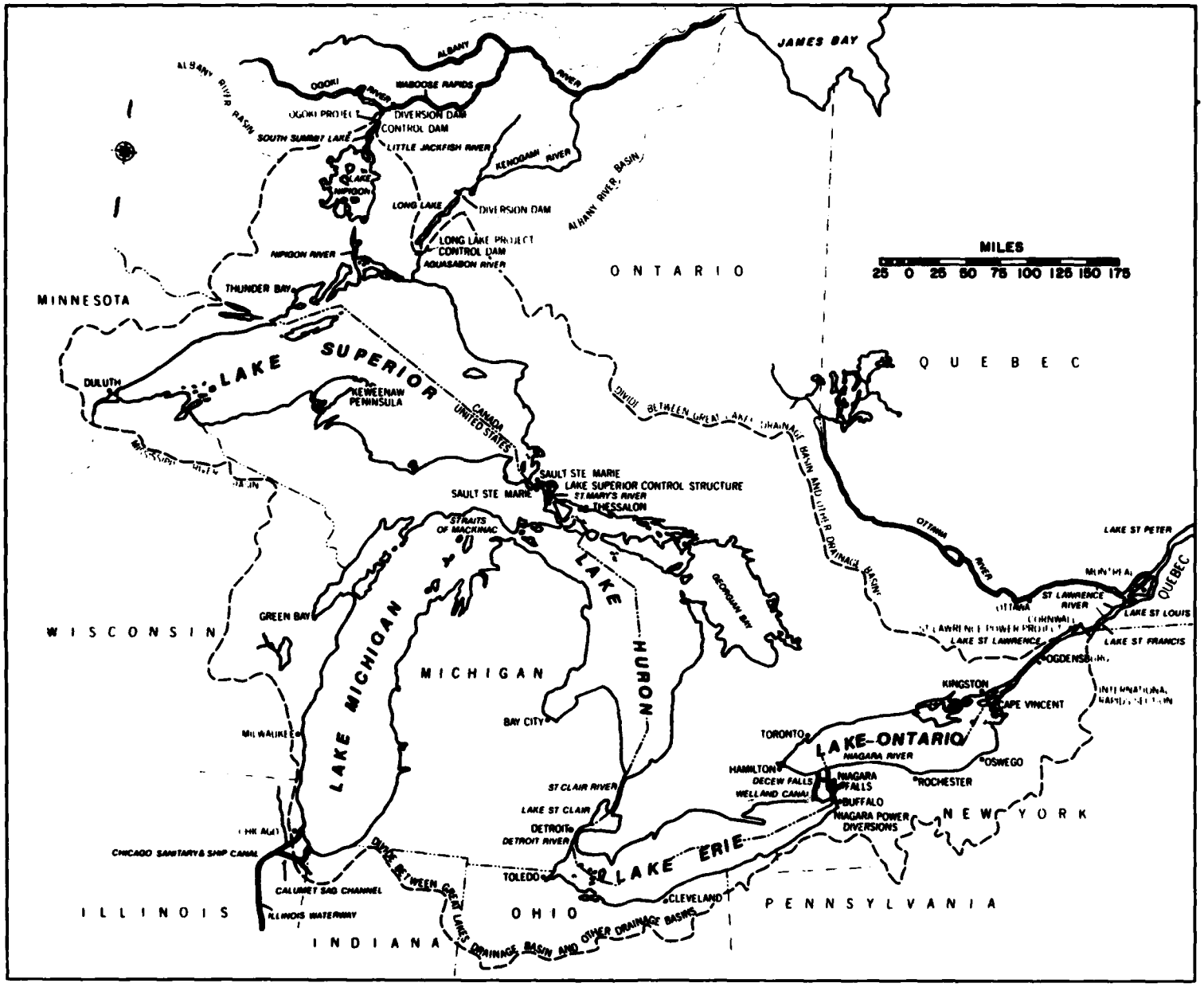
The following section describes the existing conditions which were important to the study and provides information on the natural factors which determine the level of Lake Erie. All elevations in this report are based on the International Great Lakes Datum - 1955 (IGLD-1955). Economic evaluations are based on the notion of a common dollar. A common dollar assumes that fluctuations in the exchange rate result in equivalency between United States and Canadian dollars over an extended period of time.

The Great Lakes-St. Lawrence System (Figure 1)

Lake Superior, at the head of the Great Lakes System, is the largest lake with a water surface area of 82,100 square kilometres (31,700 square miles). Its outlet, the St. Marys River, has an average discharge of 2120 cubic metres per second (75,000 cubic feet per second). Lake Superior is regulated in accordance with Plan 1977 which was developed pursuant to Orders of Approval issued by this Commission.

Lakes Michigan and Huron have virtually the same level because they are connected by the broad, deep Straits of Mackinac and are treated as one lake for hydrologic and hydraulic purposes. They have a combined area of 117,330 square kilometres (45,300 square miles). Their discharge is uncontrolled but depends upon the elevations of both Lakes Michigan-Huron and Lake Erie because the total fall between them is only eight feet. The long term average discharge of the St. Clair and Detroit Rivers is 5,100 cms and 5,210 cms (180,000 cfs and 184,000 cfs) respectively.

Lake Erie has a water surface area of 25,640 square kilometres (9,900 square miles). The uncontrolled outlet from Lake Erie is a natural bed rock weir at the head of the Niagara



GREAT LAKES-ST. LAWRENCE RIVER DRAINAGE BASIN

FIGURE I

River. The long term average outflow from Lake Erie is 5,750 cms (203,000 cfs). A small portion of the Lake Erie water, currently about 270 cms (9,400 cfs), is diverted through the Welland Canal to Lake Ontario. The Welland Canal, totally within Ontario, is a deep-draft, man-made navigational waterway, which joins Lake Erie with Lake Ontario across the Niagara Peninsula. It provides access to Lake Erie and the Upper Lakes by bypassing the falls and rapids of the Niagara River.

Immediately upstream from Niagara Falls is a gated structure which extends from the Canadian shoreline to the centre of the river. Its purpose is to maintain the natural levels of the Grass Island Pool and to provide proper distribution of flow over the Horseshoe and American Falls, while allowing for the diversion of water to the hydro-electric power plants. This structure does not regulate the levels of Lake Erie because the back water effect does not extend upstream as far as the lake.

Lake Ontario, the smallest of the Great Lakes, has a water surface area of 18,910 square kilometres (7,300 square miles). Its outlet, the St. Lawrence River, is regulated by control works in the international rapids section to meet the conditions and criteria of the Commission's Orders of Approval. The maximum outflow is limited primarily by the level of Lake Ontario and the physical characteristics of the river. The long term average discharge measured at Cornwall-Massena is about 6,800 cms (240,000 cfs).

The remainder of the St. Lawrence River is entirely in Canada. From Lake St. Francis it flows through the Beauharnois Power and Navigation Canal and also down the Côteau Rapids to Lake St. Louis, thence down the Lachine Rapids to the Laprairie Basin at Montreal, a distance of 56 kilometres (35 miles). The river then flows through a wide flat valley to Lake St. Pierre and finally to the Gulf of St. Lawrence, a distance of 560 kilometres (350 miles). The average flow in the St. Lawrence

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Level Fluctuations

The level of each of the Great Lakes depends on the balance between the total water supplies received by that lake and its discharge to the next lower lake. If the water supplies received by the lake are greater than their discharge, its level gradually rises. Conversely, if the water supplies are less than the discharge, the lake level slowly drops.

The higher lake levels in the spring and early summer and a gradual lowering of levels during the remainder of the year reflect the variations of runoff to, and evaporation from, each basin. Evaporation is always reduced considerably during periods of precipitation. This is caused by a marked reduction in solar radiation and cooler temperatures due to increased cloud cover and a resulting high humidity. These characteristics accentuate the problem of high lake levels by reducing the amount of water lost to the atmosphere during a period of high precipitation and runoff. Conversely, evaporation is high during drought conditions. These natural phenomena are the dominant causes of the long-term fluctuations of the Great Lakes. Their duration and recurrences cannot be predicted, much less controlled.

The immense storage capacities of the Great Lakes combined with their restricted outflow capacities absorb and modulate the large variations in supplies and make the Great Lakes System the finest naturally regulated fresh water system in the world. The hydraulics of the Great Lakes System are such that the change in flow to the next lower lake is small compared to the change in storage and supply conditions. The maximum discharges in the outlet rivers are only two to three times their minimum.

However, the high water supplies to any one of the Great Lakes can be stored only temporarily. Eventually all water is discharged to the next lower lake and augments its local supply. It takes two and a half years for only half of the full effect of a continuous supply change to Lakes Michigan-Huron to be realized in the outflows of Lake Erie and as long as fifteen years for the full effect of supply changes to be realized in Lake Ontario outflows.

In any given year the variations from winter low levels to summer highs average about one and a half feet on Lake Erie and nearly two feet on Lake Ontario. The long-term fluctuations in the levels of the Great Lakes are the direct result of a number of years of high or low precipitation. Their magnitude and duration are irregular and for this reason high and low water levels do not occur in any regular cycles. When either high or low water supplies occur for an extended period the corresponding extremes of water levels persist for several years after the climatic conditions have changed. Superimposed upon the long-term fluctuations are the inevitable annual fluctuations caused by seasonal variations in water supply. These tend to exaggerate the long-term fluctuations.

The most dramatic changes in water levels are the short-term fluctuations caused by strong winds and by sharp differentials in barometric pressure. They are usually of short duration, lasting less than one day, and do not represent any changes in the volume of water in the lake. On Lake Erie, these occurrences cause substantial localized changes in water levels due to the shallow nature of the lake. For example, sustained southwesterly winds over Lake Erie on April 6, 1979 caused the water level at Buffalo to rise more than two metres (seven feet) above the calm water level, with a corresponding lowering at Toledo by almost the same amount.

Environmental

There are 61,560 hectares (152,000 acres) of wetlands in the lower Great Lakes and connecting channels including the St. Clair River, Lake St. Clair and the Detroit River. These wetlands are biologically productive ecosystems and support a great diversity of plant and animal populations. The present productive state and stability of wetlands has been attained in association with historic water level fluctuations.

The commercial fishing industry harvests 23 million kilograms (50 million pounds) annually from Lake Erie and 1.1 million kilograms (2.5 million pounds) from Lake Ontario. In 1978 the value of the United States commercial catch in Lake Erie exceeded $12.2 million while the value of the Lake Ontario harvest was approximately $1.4 million. The sport fishing industry in the lower Great Lakes is a multi-million dollar business. The 1978 value of the recreational fishery was $60 million for the Ohio waters alone. Ontario reported 562,000 angler-hours in 1978 for Lake Erie. Sport fishing on Lake Ontario and the St. Lawrence River is also very important. The 1978 economic impact of all activities related to commercial and sport fishing exceeded $250 million for Lake Erie.

The shallow water environments of Lake St. Clair, the western basin of Lake Erie, Long Point Bay, the eastern basin of Lake Ontario and the St. Lawrence River are the most biological productive areas in the Great Lakes. These areas provide important spawning, nursery and feeding grounds.

Coastal Zone

Fluctuating water levels have a direct impact on the coastal zones of the Great Lakes. During the period from 1972

through 1976, Lake Erie levels reached their historic high creating substantial damage to the Lake Erie coastal zone.

The U.S. Army Corps of Engineers conducted an extensive damage survey program during the period 1972-76. The highest proportion was on Lake Erie with $119 million for total damages and costs of protection. The shoreline of Lake Erie is generally composed of unconsolidated materials and erodible bluffs with low-lying flood prone areas on the western end. There is also extensive development along its shore. It is this development combined with the shoreline characteristics and storm severity which make the Lake Erie shoreline so prone to damages.

Shoreline damages in Ontario for the period November 1972 to November 1973 amounted to almost $17 million. The severe problems were on western Lake Ontario, much of Lake Erie, and the south shore of Lake St. Clair where the shoreline is highly developed. The Quebec portion of the St. Lawrence River suffered severe damages in both 1974 and 1976. A compensation program was carried out in both instances. Total assistance and flood fighting costs were $5,274,000 in 1974 and $9,191,000 in 1976. However, these figures represent only a portion of the actual damages, since the assistance programs involved exclusion of some damages, upper limits for other damages, and deductible amounts.

The Canadian and Ontario Governments have issued flood and erosion hazard maps which delineate hazard areas in the coastal zone based on long-term erosion rates and flood mapping. In addition, flood damage reduction programs which restrict development in hazardous shore areas are in effect in both Ontario and Quebec. The United States has instituted a Coastal Zone Management Program which is administered by the individual states as well as a Flood Insurance Administration Program. Even with these programs there is concern that

further development may continue in many of the damage prone areas of the coastal zone.

Navigation

The Great Lakes, their connecting channels and the St. Lawrence River provide a continuous 3,860 kilometre (2,400 mile) deep draft waterway extending from the Atlantic Ocean into the heart of the North American continent.

Iron ore, coal, limestone and grain account for 85 per cent of the 200 million tonnes (220 million tons) of water-borne freight carried each year on the waterway. The remaining 15 per cent includes overseas general cargo, petroleum products, cement and chemicals. Lake traffic movements in the United States comprise shipments of iron ore from western Lake Superior to southern Lake Michigan and to Lake Erie, shipments of coal from southern Lake Michigan and Lake Erie ports to power plants, municipalities and industries at other United States and Canadian ports, shipments of limestone from northern Lake Huron and western Lake Erie bound for the steel industrial centres, and shipments of grain from western Lake Superior, southern Lake Michigan and western Lake Erie to Buffalo, New York and Canadian ports on the St. Lawrence River. A large portion of the Canadian commercial transits are on the St. Lawrence Seaway to and from ports on the lower St. Lawrence River. Grain constitutes the principal cargo downstream and iron ore the principal cargo upstream.

Hydro-electric Power

The existing hydro-electric plants affected by regulation of the Great Lakes have a total installed capacity of eight million kilowatts of which almost five million are in Canada and over three million are in the United States. The

principal hydro-electric power producers are publicly owned utilities. Ontario Hydro and the New York Power Authority generate electricity from the Niagara and St. Lawrence River flows. Hydro Quebec's Beauharnois-Cedars development in the Canadian portion of the St. Lawrence River utilizes the total flow of the River. In addition, there are three low head hydro-electric plants on the St. Marys River with a total rated capacity of 110 thousand kilowatts. One is a United States Government plant, while the other two are private utilities, owned by United States and Canadian companies.

Recreation

Approximately 130 kilometres (80 miles) of the shoreline from the head of the St. Clair River to the New York State-Province of Quebec border are recreational beaches accessible to the general public. About 95 kilometres (60 miles) are in Canada and 35 kilometres (20 miles) are in the United States. Many beaches are of high quality and provide a wide range of recreational beach activities. Examples are Rondeau, Long Point, and Sandbanks in Ontario, Cedar Point in Ohio, Presque Isle in Pennsylvania and Hamlin in New York.

Recreational boating is a significant activity on Lake Erie. Along the United States shoreline are 660 marinas with over 52,000 wet berths or slips and 700 moorings for recreational boats. Comparable figures were not available for the Canadian shoreline of Lake Erie since time and funding constraints did not permit the extensive field survey of the Canadian recreational boating facilities.

CHAPTER III

THE BOARD INVESTIGATION

The Commission established the International Lake Erie Regulation Study Board to undertake, through appropriate agencies in Canada and the United States, the necessary investigations and studies on its behalf and to advise it on matters that the Commission would have to consider in making its own report to the two Governments.

To assist it, the International Lake Erie Regulation Study Board organized a working committee to oversee and coordinate daily operations; two ad hoc advisory committees on economics and public information; and six investigative subcommittees on regulation, regulatory works, coastal zone, navigation, power and environmental effects. Participants were drawn from a wide array of Canadian and United States federal and state and provincial agencies throughout the Great Lakes Basin and are listed in Appendix C. To reduce the need for new field investigations, the study utilized existing information wherever possible, updating that data as necessary and limiting its geographic scope to those areas that would materially affect the results. The Board's plan of study was reviewed as part of seven public hearings held by the Commission in 1977.

Public Information Program

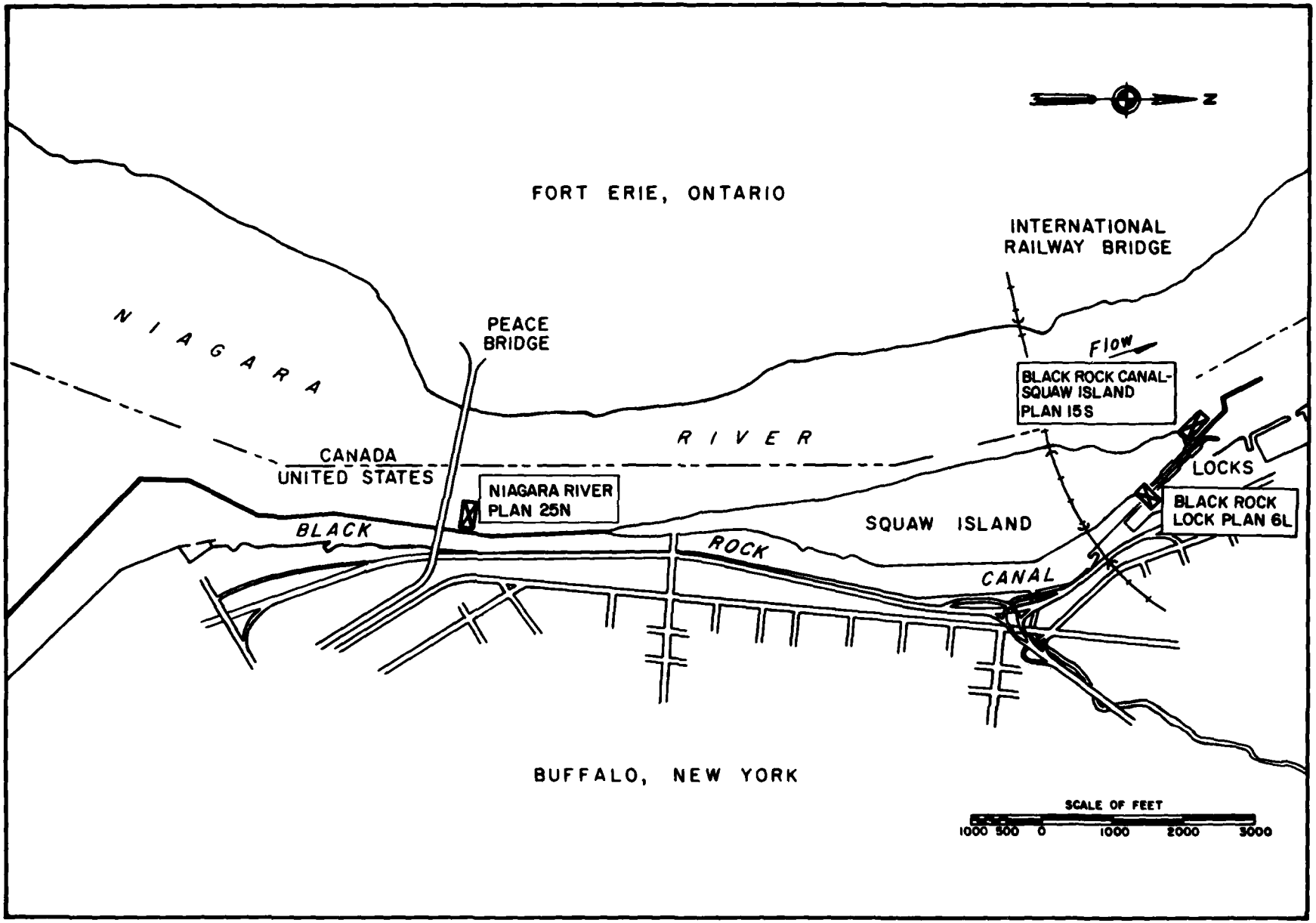
The Board established the Public Information Group in May 1979 to inform the general public of the activities and progress of the Study Board and to provide a means for public input during the study process. The basic methods were a newsletter and a series of seven public information meetings.

Over 15,000 copies of the first newsletter were distributed, about 12,500 in the United States and 2,500 bilingual newsletters in Canada. A survey was sent to 6,500 recipients of the first newsletter to determine interest in public meetings. About 1,100 responses were received. Three subsequent newsletters described the study methods, the preliminary findings, the scheduled public meetings, and the results of the study. Throughout the study, the Board maintained a mailing list of over 6,000 addressees which included all affected interests.

Seven public information meetings were conducted by the Board in the fall of 1980 to explain the preliminary findings of the study. Locations were selected on the basis of the replies to the first newsletter. Attendance varied from less than 10 to more than 50 persons, the majority of whom were shore property owners.

Alternative Plans for Regulation

The objective of the study was to examine the possibilities for the limited regulation of Lake Erie to reduce its extreme high water levels and the resulting erosion and flooding damages to coastal zone riparians. The Board's approach to the problem was to examine opportunities whereby the outflow from Lake Erie could be increased during periods of high supplies while maintaining normal levels and outflows at all other times. Out of a number of possible plans for regulation, three of the most promising based on impacts, costs and benefits were selected for detailed examination. Figure 2 gives the location of these three alternatives. A description of the alternatives and their effects is summarized in the following sections.



NIAGARA RIVER REGULATORY WORKS ALTERNATIVES

FIGURE 2

The Niagara Plan 25N (Figure 3). By excavating the narrow and shallow section of the Niagara River in the vicinity of the Peace Bridge, the outflow from Lake Erie could be increased by 710 cms (25,000 cfs). The excavated channel would be about 1040 metres (3,400 feet) long, 215 metres (700 feet) to 290 metres (950 feet) wide and up to 5 metres (17 feet) in depth. Shore protection would be required in areas of high velocity. A control structure would extend approximately 180 metres (600 feet) into the river and would contain six submersible tainter gates. The structure would offset the effect of the new channel when increased outflows are not required. The sophisticated ice control measures that would be necessary for contemplated year-round operation were not examined. The estimated cost for works required by Plan 25N as indicated in Table 3 is $134.2 million, present worth.*.

The Black Rock Canal-Squaw Island Plan 15S (Figure 4). A diversion channel 50 metres (160 feet) wide and approximately 520 metres (1,700 feet) long would be constructed parallel with and adjacent to the existing Black Rock Lock. Some diking and bank protection would be required, as well as a gated control structure at the outlet of the new channel to control lower flows. This alternative could increase Lake Erie outflows by 440 cms (15,400 cfs). However, operation of the nearby Black Rock Lock for navigation would reduce this to about 270 cms (9,600 cfs) annually. The estimated cost for works required by Plan 15S is $22.5 million, present worth.

The Black Rock Lock Plan 6L (Figure 5) This plan utilizes the existing lock as a channel but would require a new gated control structure at the upstream end of the lock. After taking account of reductions due to navigation, Lake Erie outflows could be increased by a net annual amount of 100 cms (3,700 cfs). The estimated cost for works required by Plan 6L is $13.8 million, present worth.

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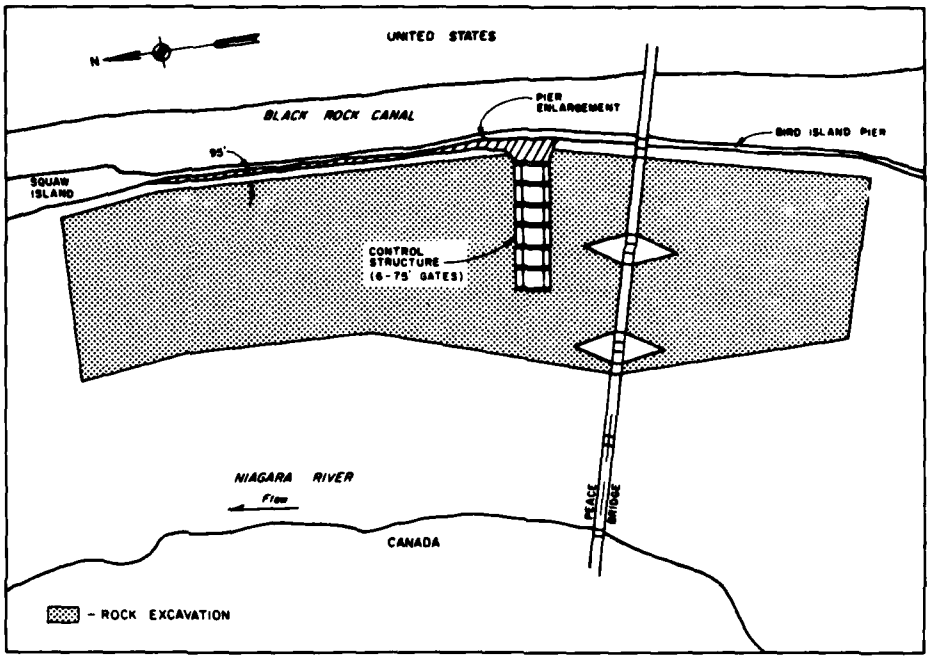
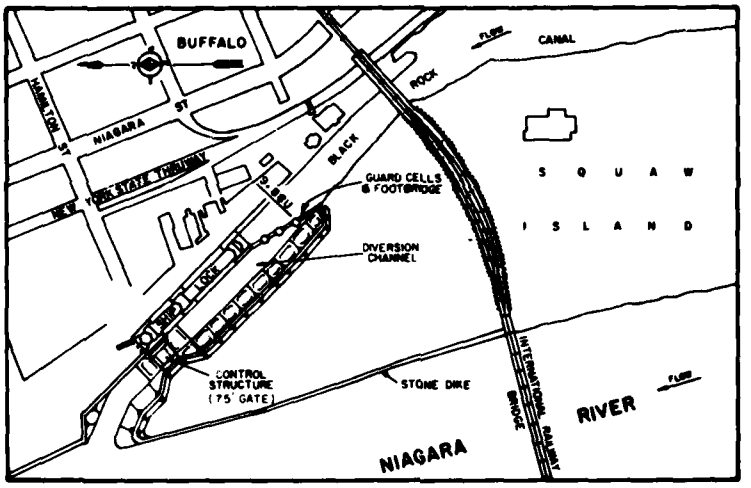
*. Present worth is the current (July 1979) value of projected future costs, discounting at 8 1/2 interest over a 50 year project life.

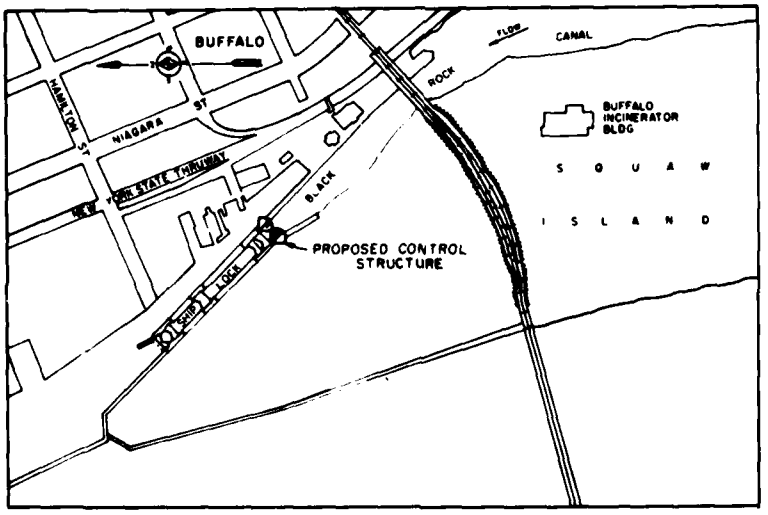


SCALE: 1" = 788' NIAGARA RIVER PLAN 25N FIGURE 3



INDICATES RIPRAP BLACK ROCK CANAL - SQUAW ISLAND PLAN 1S FIGURE 4

SCALE: 1" = 1700'



SCALE: 1" = 1700' BLACK ROCK LOCK PLAN 6L FIGURE 5

The above estimated costs are only for the regulatory works required by each of the alternative plans. Possible remedial works including dredging in the international and Canadian reaches of the St. Lawrence River to accommodate the increased flows resulting from each plan are discussed in the next section. The costs of these remedial works are included in Table 3.

The Board developed an index to trigger the additional releases called for by the Lake Erie regulation plans. Since 80 per cent of the average water supply comes from Lakes Superior, Michigan and Huron, a twelve-month moving mean water supply to these lakes was selected as the future supply to Lake Erie. This permits additional releases prior to the rise of Lake Erie levels and the cessation of such releases prior to falling lake levels. Such a procedure maximizes the reduction of high water levels while minimizing the impact on the mean and minimum Lake Erie water levels.

Effects of Alternative Plans

In order to have a common basis on which to compare the effects of various Lake Erie regulation plans, a set of lake levels and outflows termed the basis-of-comparison was developed. These levels and outflows reflect a constant or fixed regime in the Great Lakes-St. Lawrence River System over the study period. The levels and outflows resulting under any Lake Erie regulation plan were compared with this basis-of-comparison, thus providing a consistent evaluation over the period of record.

The historic Great Lakes levels and outflows could not be used for the basis-of-comparison because various changes in diversions, size of connecting channels and control works have altered the historic pattern. Therefore, the historic record was adjusted so that the resulting levels and flows would be those that would have been experienced throughout the 1900-1976

period if current (1977) conditions had been in existence. These conditions include the current plans of regulation for Lake Superior (Plan 1977) and Lake Ontario (Plan 1958-D) as well as constant diversions of 140 cms (5,000 cfs) into Lake Superior from Long Lac and Ogoki, 90 cms (3,200 cfs) out of Lake Michigan at Chicago, and 200 cms (7,000 cfs) from Lake Erie to Lake Ontario by the Welland Canal. The adjusted set of levels and flows is called the basis-of-comparison. The basis-of-comparison is compared with the levels and flows resulting from each alternative plan to determine the expected effect or impact of that alternative.

The two primary hydrologic factors evaluated by the Board to illustrate the effects of limited regulation of Lake Erie were lake levels and outflows. Analysis of these factors included the consideration of their maximum, mean and minimum monthly values, range, duration and seasonal distribution. For this report, only lake levels were chosen to illustrate effects of limited Lake Erie regulation.

The water levels of Lakes Superior, Michigan-Huron and Erie, and their connecting channels would be changed in varying amounts by the alternative projects to regulate Lake Erie. These changes are summarized in Table 1. The effects of Lake Erie regulation plans on Lake Superior would be minimal. There would be no change in the Lake Superior maximum stage and the extreme low levels under regulation plans would be lowered somewhat. Slightly greater changes in level would be experienced on Lakes Michigan-Huron. All three regulation plans would reduce the maximum and minimum stages with the maximum reduction occurring under the Niagara Plan (25N). On Lake Erie limited regulation could lower the maximum level by 4.5 cm (0.15 foot) if the Black Rock Lock plan (6L) was used and 12.8 cm (0.42) foot for the Squaw Island plan (15S). The maximum lowering effect of 32.6 cm (1.07) feet would be achieved under 25N.

Table 1 - Changes in Upper Lakes and Lake Erie Water Levels due to Limited Regulation of Lake Erie [in metres and (feet)]

	BASIS OF COMPARISON	Plan 6L		Plan 15S		Plan 25N	
		Levels	Changes* from BOC	Levels	Changes* from BOC	Levels	Changes* from BOC
LAKE SUPERIOR							
MEAN	183.014 (600.440)	183.011 (600.430)	-.003 (-.010)	183.005 (600.410)	-.009 (-.030)	182.993 (600.370)	-.021 (-.070)
MAXIMUM	183.469 (601.930)	183.469 (601.930)	.000 (.000)	183.469 (601.930)	.000 (.000)	183.469 (601.930)	.000 (.000)
MINIMUM	182.481 (598.690)	182.478 (598.680)	-.003 (-.010)	182.469 (598.650)	-.012 (-.040)	182.459 (598.620)	-.022 (-.070)
RANGE	0.988 (3.240)	0.991 (3.250)	+.003 (+.010)	1.000 (3.280)	+.012 (+.040)	1.010 (3.310)	+.022 (+.070)
LAKES MICHIGAN-HURON							
MEAN	176.257 (578.270)	176.248 (578.240)	-.009 (-.030)	176.229 (578.180)	-.028 (-.090)	176.190 (578.050)	-.067 (-.220)
MAXIMUM	177.135 (581.150)	177.116 (581.090)	-.019 (-.060)	177.086 (580.990)	-.049 (-.160)	177.013 (580.750)	-.122 (-.400)
MINIMUM	175.403 (575.470)	175.397 (575.450)	-.006 (-.020)	175.388 (575.420)	-.015 (-.050)	175.370 (575.360)	-.033 (-.110)
RANGE	1.732 (5.680)	1.719 (5.640)	-.013 (-.040)	1.698 (5.570)	-.034 (-.110)	1.643 (5.390)	-.089 (-.290)
LAKE ERIE							
MEAN	173.968 (570.760)	173.940 (570.670)	-.028 (-.090)	173.898 (570.530)	-.070 (-.230)	173.788 (570.170)	-.180 (-.590)
MAXIMUM	174.833 (573.600)	174.788 (573.450)	-.045 (-.150)	174.705 (573.180)	-.128 (-.420)	174.507 (572.530)	- .326 (-1.070)
MINIMUM	173.154 (568.090)	173.148 (568.070)	-.006 (-.020)	173.132 (568.020)	-.022 (-.070)	173.078 (567.840)	-.076 (-.250)
RANGE	1.679 (5.510)	1.640 (5.380)	-.039 (-.130)	1.573 (5.160)	-.106 (-.350)	1.429 (4.690)	-.250 (-.820)

*(-) below and (+) above BOC

Note: The number of significant figures in the data showing water levels in Tables 1 and 2 of this report has been selected for uniformity of presentation and does not necessarily reflect the degree of accuracy of the data.

Lake Ontario's levels and outflows are controlled by regulatory works in the St. Lawrence River to meet as nearly as possible the conditions and criteria contained in the Commission's Orders of Approval. When the St. Lawrence Power Project was constructed in the 1950's, significant dredging was undertaken to increase the channel capacity of the St. Lawrence River and thereby permit greater control over Lake Ontario outflows than occurred under natural conditions. Plan 1958-D was developed in 1963 to achieve the conditions and criteria of the Commission's Orders of Approval. The regulation plan as well as the increased channel capacity, however, were designed to accommodate the water supplies to Lake Ontario that had occurred during the period 1860-1954. The plan was unable to achieve all of the criteria contained in the Commission's Orders during either the extreme low supplies which occurred during the early 1960's or the extreme high supplies which occurred during the 1970's. The maximum level prescribed for Lake Ontario was exceeded during the 1970's because not all of the high supplies could be discharged through the St. Lawrence River even with the application of Criterion (k)* of the Commission's Orders because of the severe damage that would have resulted downstream due to channel limitations. Such damage would have violated other requirements of the Commission's Orders relating to the protection of downstream interests.

Conditions downstream, in Lake Ontario and the St. Lawrence River, would be influenced by both a Lake Erie project and the manner in which Lake Ontario outflows are regulated.

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* Criterion (k) reads:
In the event of supplies in excess of the supplies of the past as adjusted, the works in the international rapids section shall be operated to provide all possible relief to the riparian owners upstream and downstream. In the event of supplies less than the supplies of the past as adjusted, the works in the international rapids section shall be operated to provide all possible relief to navigation and power interests.

Consequently, three categories were considered in the combined regulation of Lakes Erie and Ontario including two which were devised in order to minimize the adverse effects of increased Lake Erie outflows. The hydraulic effects of the three alternative Lake Erie projects are discussed below and summarized in Table 2 for each Lake Ontario regulation category.

Category 1. Lake Ontario would be regulated in accordance with the existing Plan 1958-D with discretionary authority. Thus Category 1 does not make any allowance for the fact that Lake Erie would be partially regulated.

Table 2 indicates that as the outflow of Lake Erie increases, the range of levels also increases for all regulation plans under Category 1 for Lake Ontario. However, there would be virtually no effect below Lake St. Louis.

Category 2. The operating rules of Plan 1958-D would be modified to accommodate Lake Erie regulation and to satisfy the Commission criteria for Lake Ontario regulation to the same degree as has occurred under actual operation. These modifications would include raising the Lake St. Louis outflow limit that governs Lake Ontario outflows during the ice break-up period in the Lake St. Louis-Montreal areas and the annual flood discharge of the Ottawa River, adjusting the minimum outflow of Lake Ontario, permitting larger changes in Lake Ontario outflow from week to week and modifying water depths and velocities in the navigation channels.

With Category 2 regulation of Lake Ontario, the maximum, minimum and mean stages generally would be slightly increased.

Category 3. For Category 3, Plan 1958-D was modified so that Lake Ontario regulation satisfied the criteria for the 1900-1976 flows and included the modifications due to the three alternatives for limited regulation of Lake Erie.

Table 2 - Changes in Lake Ontario Water Levels due to Limited Regulation of Lake Erie [in metres and (feet)]

	BASIS OF COMPARISON (BOC)	PLAN 6L		PLAN 15S		PLAN 25N	
		Levels	Changes* from BOC	Levels	Changes* from BOC	Levels	Changes* from BOC
Category 1							
MEAN	74.557 (244.610)	74.566 (244.640)	+.009 (+.030)	74.569 (244.650)	+.012 (+.040)	74.563 (244.630)	+.006 (+.020)
MAXIMUM	75.398 (247.370)	75.404 (247.390)	+.006 (+.020)	75.456 (247.560)	+.058 (+.190)	75.438 (247.500)	+.040 (+.130)
MINIMUM	73.704 (241.810)	73.682 (241.740)	-.022 (-.070)	73.637 (241.590)	-.067 (-.220)	73.573 (241.380)	-.131 (-.430)
RANGE	1.694 (5.560)	1.722 (5.650)	+.028 (+.090)	1.819 (5.970)	+.125 (+.410)	1.865 (6.120)	+.171 (+.560)
Category 2							
MEAN	74.557 (244.610)	74.572 (244.660)	+.015 (+.050)	74.582 (244.690)	+.024 (+.080)	74.588 (244.710)	+.031 (+.100)
MAXIMUM	75.398 (247.370)	75.389 (247.340)	-.009 (-.030)	75.414 (247.420)	+.016 (+.050)	75.423 (247.450)	+.025 (+.080)
MINIMUM	73.704 (241.810)	73.774 (242.040)	+.070 (+.230)	73.798 (242.120)	+.094 (+.310)	73.826 (242.210)	+.122 (+.400)
RANGE	1.694 (5.560)	1.615 (5.300)	-.079 (-.260)	1.616 (5.300)	-.078 (-.260)	1.597 (5.240)	-.097 (-.320)

Category 3	ADJUSTED BASIS OF COMPARISON (ABOC)	PLAN 6L		PLAN 15S		PLAN 25N	
		Levels	Changes* from ABOC	Levels	Changes* from ABOC	Levels	Changes* from ABOC
MEAN	74.563 (244.630)	74.566 (244.640)	+.003 (+.010)	74.569 (244.650)	+.006 (+.020)	74.575 (244.670)	+.012 (+.040)
MAXIMUM	75.215 (246.770)	75.221 (246.790)	+.006 (+.020)	75.237 (246.840)	+.022 (+.070)	75.234 (246.830)	+.019 (+.060)
MINIMUM	73.877 (242.380)	73.859 (242.320)	-.018 (-.060)	73.865 (242.340)	-.012 (-.040)	73.905 (242.470)	+.028 (+.090)
RANGE	1.338 (4.390)	1.362 (4.470)	+.024 (+.080)	1.372 (4.500)	+.034 (+.110)	1.329 (4.360)	-.009 (-.030)

* (-) below and (+) above adjusted BOC or ABOC.

The extensive changes to Plan 1958-D for Category 3 required two additional steps. First, the historic record was routed through the modified Plan 1958-D to produce a new set of base conditions, called adjusted basis-of-comparison, against which the Lake Erie regulation projects could be compared. Second, enlargements in the St. Lawrence River necessary to accommodate the increased supplies were identified. The purpose of this change was to satisfy the conditions and criteria of the Commission's St. Lawrence Order of Approval, while at the same time accommodating higher inflows from Lake Erie.

The adjusted basis-of-comparison levels and flows would require dredging the St. Lawrence River in the reach from Prescott, Ontario-Ogdensburg, N.Y. to Morrisburg, Ontario to provide additional capacity above existing conditions. The total present worth of all St. Lawrence channel excavation to accommodate the adjusted basis-of-comparison flows is $80.1 million consisting of $33.6 million in the international reach and $46.5 million in the Canadian reach. By contrast, the estimated total present worth of benefits from this work is $5.2 million. Therefore, as a project separate and distinct from any Lake Erie regulation, St. Lawrence dredging to accommodate the historic high flows is by a wide margin not economically justified.

Although dredging the St. Lawrence is by itself uneconomic, the impacts of Lake Erie regulation alternatives were tested against the adjusted basis-of-comparison. Alternatives 15S and 25N would require smaller amounts of additional dredging in the St. Lawrence and these costs are included in Table 3.

Under Category 3, the adjusted basis-of-comparison maximum stage would be reduced to the maximum permissible stage of 75.22 metres (246.77 feet). The three lake plans, however, would increase the maximum stages slightly, but this increase would be less than 3.0 cm (0.1 foot).

Environmental Effects

Due to time and resource constraints coupled with a lack of economic feasibility for the projects examined, only a preliminary evaluation of environmental effects was undertaken. The geographic coverage was limited to the section between the Lake Huron outlet and the beginning of the Canadian reach of the St. Lawrence river.

Water Quality - Lakes Erie and Ontario water quality generally would not be significantly altered by any of the regulation plans. The greatest impacts both adverse and beneficial would result from Plan 25N.

The most significant impact of lowered levels on Lakes Erie and St. Clair would be the reduction in volume in shallow embayments with a small lake/bay interface. The resultant loss in dilution capacity would enhance the potential for increased embayment pollutant concentration. This condition could become critical in the event of a "slug" pollutant load such as an accidental spill or a bypass due to equipment malfunction.

All of the regulation plans would reduce nearshore turbidity on Lake Erie due to reductions in shoreline erosion. However, the projected mean turbidity decreases would be relatively small even under Plan 25N.

The regulation plans would not significantly affect the quantity of water available for dilution of wastes emanating from nearshore outfalls. However, some aesthetic drawbacks in the nearshore area might be noticed due to the possible exposure of outfall heads.

Wildlife/Wetlands - The lowering of the long-term water levels of Lakes Erie and St. Clair could create large areas of sedge marsh and meadow environments, which would

decrease the diversity and density of wetland-dependent wildlife species while enhancing habitat conditions for species not necessarily dependent on wetlands. The landward edges of wetlands exposed and no longer periodically flooded would tend to progress to shrubs and trees if left undisturbed by human activity. A more probable result would be the encroachment of development into the resultant dry zone along the perimeter of the wetlands.

Plan 25N would be the most damaging plan, resulting in permanent loss of some wetland area especially around the landward edges of existing wetlands. Damages to the vegetative structure of wetlands, resulting from Plan 15S, could also be extensive, but not as great as Plan 25N. It is thought that Plan 15S, at least for Lake St. Clair, would provide sufficient variability in lake levels to promote species diversity. In Lake Erie, however, there may not be ample variation. Plan 6L would be the least detrimental, although vegetative zone shifts of a lesser magnitude from open-water aquatics to emergents and sedge/meadow would still occur.

All three proposed regulation plans would produce similar changes in the Lake Ontario water level regime. The impacts of a reduced predominance of sedge/meadow and emergent zones during low and mean water periods and an increased die-back of emergents during increased high water periods are, overall, regarded as indeterminable to slightly beneficial to wetlands and wetland-dependent wildlife.

Fish - Site-specific studies would be required to determine how the regulation-induced changes in water levels would impact the fish utilizing productive nearshore zones. If the habitat of a fish species were modified severely or destroyed through lake level changes, then the fish species would have the potential of being affected to a similar degree. The impact would be felt throughout the system.

It does appear that the construction and operation of the proposed regulatory works could cause adverse environmental effects of fish stocks and fishing activities in the upper Niagara River. It is also possible that the proposed dredging in the St. Lawrence River as a result of Category 3 could have a detrimental effect on the fish habitat in the St. Lawrence River.

Economic Evaluation

Each of the regulation plans in Categories 1 and 2 was evaluated by comparing the resulting hydrologic effects with the basis-of-comparison. The regulation plans in Category 3 were compared with the adjusted basis-of-comparison. Procedures were developed to translate incremental changes into dollar benefits or losses for each of the four major interests: coastal zone properties, commercial navigation, power and recreational beaches and boating. All monetary estimates are based on 1979 price levels in common dollars at 8 1/2 percent interest and on a project life of 50 years. All annual benefits and losses were converted to present worth to facilitate comparison. The Board's findings are presented in Table 3.

Coastal zone properties are subject to two basic types of damage, inundation caused by storm water levels and erosion. Damage data along the United States shoreline were based on a four-year survey period, from September 1972 to September 1976. The Canada-Ontario shore damage survey covered the period November 1972 to November 1973. The inundation events of 1974 and 1976 were used as the basis for damage in the Quebec portion of the St. Lawrence River.

Table 3 - Summary of Benefits, (Losses)and (Costs) as Present Worth (Millions of Dollars)[1]

Regulation Plan	6L			15S			25N		
	Against B.O.C.		Against Adj. B.O.C	Against B.O.C.		Against Adj. B.O.C.	Against B.O.C.		Against Adj. B.O.C.
Category	1	2	3	1	2	3	1	2	3
A.Benefits(Losses)									
Coastal Zone									
U.S.	9.7	9.0	9.8	24.1	23.3	24.7	52.8	51.3	53.2
Canada	2.1	2.1	1.8	3.5	3.3	2.5	7.0	6.3	5.8
Total	11.8	11.1	11.6	27.6	26.6	27.2	59.8	57.6	59.0
Navigation									
U.S.	(8.2)	(8.2)	(8.2)	(24.4)	(24.4)	(24.4)	(72.6)	(72.5)	(72.5)
Canada	(3.8)	(2.5)	(4.0)	(12.9)	(11.3)	(13.1)	(44.7)	(41.9)	(42.9)
Total	(12.0)	(10.7)	(12.2)	(37.3)	(35.7)	(37.5)	(117.3)	(114.4)	(115.4)
Power									
U.S.	(3.0)	3.3	(1.9)	(3.4)	3.3	2.2	(15.7)	(5.0)	(11.2)
Canada	(5.4)	(5.5)	(6.4)	(14.8)	(15.0)	(14.4)	(12.9)	(13.0)	(12.4)
Total	(8.4)	(2.2)	(8.3)	(18.2)	(11.7)	(12.2)	(28.6)	(18.0)	(23.6)
Recreation									
U.S. Beaches:	7.0	6.6	5.8	21.5	20.4	20.2	51.9	50.7	49.7
U.S. Boating:	(5.2)	(5.2)	(5.9)	(11.7)	(10.4)	(11.5)	(36.0)	(34.5)	(35.1)
Can. Beaches:	2.6	2.3	2.6	7.0	6.2	7.0	18.9	15.8	18.9
Total	4.4	3.7	2.5	16.8	16.2	15.7	34.8	32.0	33.5
Total Benefit or(Loss)	(4.2)	1.9	(6.4)	(11.1)	(4.6)	(6.8)	(51.3)	(42.8)	(46.5)
B.(Costs)									
Total Regulatory and Remedial Works Cost									
Niagara River	(13.8)	(13.8)	(13.8)	(22.5)	(22.5)	(22.5)	(134.2)	(134.2)	(134.2)
St. Lawrence									
1. Required for L.Ontario Regulation Only			(80.1)			(80.1)			(80.1)
2.Required for L. Erie Regulation in Addition to 1			0			(16.6)			(5.5)
Total Niagara and St. Lawrence	(13.8)	(13.8)	(93.9)	(22.5)	(22.5)	(119.1)	(134.2)	(134.2)	(219.8)
Total for Limited Regulation of L. Erie	(13.8)	(13.8)	(13.8)	(22.5)	(22.5)	(39.1)	(134.2)	(134.2)	(139.7)

1 In July 1979 Price Levels at 8-1/2 Percent Interest

Source: International Lake Erie Regulation Study Board Report, July 1981

The stormwater stage-damage curves were based on recorded storm water levels and known damages. Inundation damages were derived for each reach along the shoreline. The damages of the Quebec portion of the St. Lawrence River were based on the combined probability of the outflow from Lake Ontario, local inflow and the Ottawa River flows to the Montreal region.

Wave energy is the main factor causing coastal zone damage. An index of damage was determined by using the wave intensity, mean beach slope and the elevation of the bluff toe above the reference level. This index was computed for each reach and then used to convert stage-energy curves to stage-damage curves. Sensitivity analysis was conducted on both inundation and erosion evaluations.

A survey of community and industrial water intakes was carried out by the Board. The pumping costs for water levels under the basis-of-comparison were calculated and then compared with the pumping costs for conditions with limited regulation of Lake Erie to determine a benefit or loss.

Limited regulation of Lake Erie would result in an overall reduction in inundation and erosion damages for all regulation plans in all categories. The greatest reduction could occur using the Niagara River regulation plan. Reduced benefits to shore property owners would be derived from the Squaw Island and Black Rock Lock regulation plans.

Commercial navigation costs are affected by available water depths in the connecting channels and the harbours of the Great Lakes or the legally allowable draft specified under seasonal load line regulations. In most cases only a portion of the reduction in Lake Erie levels affects navigation. Detailed mathematical procedures were developed to calculate the annual cost of transporting bulk water-borne commerce in the Great Lakes system under any given regime of water levels.

Any change in the loading capacity of ships on a route results in a change in the number of trips required to move a given volume of goods over that route. A change in the number of trips alters the total operating expenses in direct proportion to the time involved.

The Board took into account projections of future bulk water-borne commerce, the future vessel fleet, traffic patterns, operating costs, the navigation seasons and the capacity of the Welland and Soo Locks. The computer programs calculated the difference in monthly water levels between the basis-of-comparison and the alternative regulation plans, by lake, for each month of the 77 year period. The allowable draft for each trade route and the ship operating time to move the projected cargoes were computed. These costs were compared to the transportation cost for the basis-of-comparison. The difference is the benefit or loss to shipping. These computations were subjected to a sensitivity analysis.

Table 3 indicates that there could be losses to commercial navigation for all regulation plans in all categories and that these losses would increase as Lake Erie outflows increased. The Board found that dredging in the connecting channels and harbours in the United States as an alternative for offsetting commercial navigation losses due to limited regulation of Lake Erie was non-economical.

Power generation at the hydro-electric plants on the St. Marys, Niagara and St. Lawrence Rivers depends upon the net head and flows available. The difference between the power generated under the basis-of-comparison and the power generated under each regulation plan is the gain or loss of dependable capacity and energy output at each plant or group of plants.

Computer programs were developed to determine the amount of water available, the corresponding head, average monthly energy output and the peak output for the 77 year

regime. Account was taken of the provisions of the Niagara Treaty and IJC Orders of Approval which impose limitations on diversions for power as well as head losses and diversion capabilities of each plant, navigation requirements, peaking and ponding, and ice conditions. Replacement of dependable capacity and energy varied with the utility. The Ontario system values are based on a mixture of coal and nuclear power; Quebec values are based on hydro-electric until 1995 and nuclear thereafter; and New York values are based on oil as the replacement fuel. The Board estimated the average annual cost replacement over the economic life of the project, 1985-2034, to convert the effects into a monetary value.

Limited regulation of Lake Erie would result in power losses for all regulation plans in all categories. The most significant losses would be experienced by Canadian power plants on the Niagara River because of the limited capacity of the high efficiency Beck generating plant. Consequently, the additional water would be used at the less efficient Cascade plants or passed over the falls.

Recreational beach areas are affected by fluctuating water levels. The Board considered only the beaches accessible to the general public. An increase or decrease of the dry beach area has an impact on swimming opportunities, the indicator for beach use. Account was taken of the length, width and slopes of beaches, turnover rate, number of suitable days, use patterns and population growth. The value to recreationists is a function of the distance travelled and the weighted entrance fee. A dollar value of the associated costs was used to evaluate the benefits or losses.

Recreational beach benefits would be experienced under all Lake Erie regulation plans in all categories.

Recreational boating investigation was limited to the United States shoreline from the St. Clair to the St. Lawrence Rivers. The Board considered only the effects of water level fluctuations for activities originating at commercial facilities such as marinas. Boats berthed at private residences or cottages were not considered. The measured impacts in this study are the effects of low water levels that prevent safe ingress or egress from boat slips or moorings. The analysis considered the effects of various water levels on boating use and the probability of a water level being equalled or exceeded during the time period. The damage that would be expected to occur in any one year was computed. The difference between average annual damages under each regulation plan and the basis-of-comparison is the benefits or losses attributable to each regulation plan.

Table 3 indicates that recreational boating losses in the United States would occur under all Lake Erie regulation plans in all categories.

Findings

Table 3 is a summary of the economic benefits and/or losses to Great Lakes interests as a result of limited regulation of Lake Erie expressed in terms of present worth value. It also contains the costs of the regulatory works in the Niagara River and the remedial works in the St. Lawrence River.

Table 3 shows that the total net benefits of all plans for limited regulation of Lake Erie under all study categories would be negative, or (in the case of Plan 6L under Category 2) would have benefits far exceeded by associated costs. In summary, the benefit-to-cost ratio for all plans under all study categories shows that limited regulation of Lake Erie would not be economically justified.

The benefit-to-cost analysis of limited regulation of Lake Erie primarily consisted of a comparison of the probable economic benefits that would be experienced by the major Great Lakes interests, and the costs of the necessary regulatory and/or remedial works. The hydro-electric power interest is an example where well-established methods are available to translate water level and flow changes to precise monetary terms. The probable economic benefits or losses to the other interests studied were based on the best available methodologies and data. As a result, the Board examined how variations in some of the benefits or losses would affect the benefit-to-cost comparison. The analysis showed that although the benefits to coastal zone interests might be higher than those projected by the Board, the overall benefit-cost ratio would remain negative for all regulation plans.

Chapter IV

PUBLIC HEARINGS

The ten public hearings conducted by the International Joint Commission were an integral part of the inquiry. The purpose of these public hearings was to provide convenient opportunity for all those interested in the water levels of the Great Lakes to express their views and to convey relevant and factual information to the Commission.

Seven initial hearings were held in November and December 1977 to obtain opinions and guidance in planning the investigation from concerned individuals, private organizations and public agencies. Following the distribution of the Board's final report the Commission conducted three public hearings to obtain comments on the Board's report and further views of interested persons, associations and governmental agencies.

In accordance with the Commission's Rules of Procedure, notices of all public hearings were published in the *Canada Gazette*, the United States *Federal Register* and local newspapers in both countries. In addition, notices and press releases were mailed to numerous individuals, associations, elected representatives in the region, the mass media and governmental agencies.

At the ten public hearings all those interested were given an opportunity to express their views orally or to present documentary evidence. The Commission also accepted written submissions received subsequent to the respective hearings. Statements were made by elected representatives, private individuals, citizen groups, business and industrial representatives and officials from federal, state, provincial and municipal agencies. The names of those who testified at the hearings are listed in Appendix D.

Verbatim transcripts of all hearings and all written submissions made at and subsequent to the hearings are on file and available for examination at the offices of the Commission in Ottawa and Washington, D.C.

The 1977 Hearings

The initial hearings on this reference were held in 1977 at Chateauguay, P.Q. on November 15; Chicago, Illinois on November 16; Peoria, Illinois on November 17; Cleveland, Ohio on December 5; Buffalo, N.Y. on December 6; Windsor, Ontario on December 7; and Toronto, Ontario on December 8. Their purpose was to receive testimony concerning the adequacy of the Commission's directive to the Board and the Board's Plan of Study, and other testimony relating to the concerns of the various interest groups in the study area.

The testimony received at these hearings pointed clearly to the fact that the interests and requirements of individuals and groups vary widely according to their type and their geographical location. They were often conflicting. The salient points of the testimony received at the hearings are paraphrased below:

> The Commission heard testimony in support of regulation of Lake Erie from residents of the lakeshore. The damages and erosion caused by wind and wave action were cited as the major concern related to lake levels. The Commission was told that any actions which would reduce lake levels would reduce these damages. One witness, however, questioned the wisdom of spending money on this study since even if regulation was implemented, lake levels would be reduced by only a small amount, and wind and wave damages, the major problem, would remain uncontrolled.

The Commission was also held of the adverse impacts such regulation might have on other interests, particularly those downstream. Efforts to reduce high levels on Lake Erie could result in the passage of additional flows downstream. These extra flows could exacerbate high lake levels with associated flooding and shoreline damages on Lake Ontario, Lake St. Louis on the St. Lawrence River, and also at Montreal. Moreover, these added flows would likely occur at such a time that they could not be used for power generation and would have to be spilled downstream "unused" for electrical generation. This would result in large losses to the power generation industry in both countries at Niagara Falls and at the Moses-Saunders facilities on the St. Lawrence River, as well as at the Cedar Rapids and Beauharnois plants in Quebec. Conversely, during periods of low water supplies and lake levels, outflows from Lake Erie would be reduced to maintain higher Lake Erie levels, and consequently downstream low flow and level conditions would be worsened to the detriment of navigation, power, and other interests.

Some witnesses noted the two possibilities previously considered to regulate lake levels. The first of these, excavation and placement of a structure in the Niagara River, would damage the valuable fishery in the river. The second, the so-called Squaw Island Diversion, would clash with existing and planned uses for the island and could have adverse effects on municipal water supply intakes through its effects on River currents. Another witness felt that the effects of lake level regulation on shallow water fisheries of the lakes must be determined. However, he noted that there are very little data available at present on which to assess these impacts. New information would have to be gathered by the Study Board.

[illegible] Study Board [illegible] of property, [illegible] Study Board because of [illegible] Ohio. It was felt [illegible] a fair presentation of shoreline damages and associated "social" costs.

One witness raised the matter of landfills which restrict outflow from Lake Erie, and inquired as to what could be done.

The 1982 Hearings

The Commission's final hearings in preparation for its report to Governments on regulation of Lake Erie were held in 1982 at Cleveland, Ohio on November 17; Niagara Falls, Ontario on November 18; and Cheektowaga, New York on November 18. The hearings were held to receive public comment on the International Lake Erie Regulation Study Board's final report to the Commission. The salient points of the testimony received at these hearings are paraphrased below:

A number of residents of the Lake Erie lakeshore, whose property had suffered substantial storm damages during the 1972-1974 highwater period, spoke in favour of the need for immediate measures to provide protection that would reduce future property losses. Resources, they said, should be directed towards preventive measures now, rather than funding further studies or repeating the costly disaster relief program that followed the damaging storms of the early 1970's.

The Lake Erie Regulation Study Board's report was seen by some as being biased in favour of shipping and hydroelectric power interests and against shore

property owners. One individual commented that while the Board had provided estimates of the costs of regulatory works and the projected navigation and power company losses under regulation, it had failed to provide adequate information, such as the the extent of the U.S. Small Business Administration (SBA) disaster relief funding of 1972, 1973 and 1974 as a measure of the benefits of regulation to property owners. A number of individuals spoke in favour of implementing the Board's recommendation concerning coastal zone management practices. This was tempered by the observation that such practices were primarily for new structures and therefore had limited application to most property owners.

Several individuals commented on the effect of external influences on Lake Erie water levels, citing upstream diversions into the Great Lakes and the cumulative effect of landfills and other man-made structures especially in the Niagara River as causes for increasing water levels in Lake Erie. While dredging and the reduction or elimination of diversions were suggested as solutions it was also noted that the former action might adversely affect certain fish spawning areas.

CHAPTER V

SUPPLEMENTAL INFORMATION

Concurrent with this study of limited regulation of Lake Erie, the Commission has conducted an investigation of diversions and consumptive uses of Great Lakes water pursuant to a separate reference from Governments. Although the Commission has not yet completed its work under the Diversions and Consumptive Uses Reference, certain information that the Commission has received under that reference is pertinent to the subject of limited regulation of Lake Erie.

First, the average flow through the Welland Canal has been increased in recent years. The Commission's International Great Lakes Diversions and Consumptive Uses Study Board has reported that the Welland Canal diversions increased from an average of 215 cms (7,600 cfs) during 1952-1976 to an average of 220 cms (7,800 cfs) during 1952-1979, with a maximum value of 265 cms (9,300 cfs) in 1979. This increase in flows has had the effect of slightly lowering water levels of Lake Erie.

Second, the consumptive use of Great Lakes water is projected to increase from the estimated 1975 rate of 140 cms (4,900 cfs) to an amount which could range from 455 cms (16,000 cfs) to 1050 cms (37,000 cfs) by the year 2035. Consumptive uses of water are defined as that portion of water withdrawn from and not returned to the Great Lakes due to such factors as evaporation, leakage and incorporation into products.

The net effect of these projections would be to lower Lake Erie water levels within the range of 11.6 to 34.4 cm (0.38 to 1.13 feet). The Commission emphasizes that these projections are simply estimates based upon the

best information available at this time. The actual consumptive use and consequent effect on Lake Erie water levels will be dependent upon a number of future actions and events that cannot be predicted accurately at this time. These include the rate of economic growth, future water supplies and the possible adoption of water conservation measures in both the United States and Canada.

While the cumulative effect of the two factors discussed above cannot be determined with precision, it is clear that their effect will be to reduce Lake Erie water levels at all times. Consequently, the need for and benefits from limited regulation of Lake Erie as examined in this report could be reduced by these events.

It should be noted that the alternatives examined for Lake Erie regulation in this report are limited to those which increased Lake Erie outflows. The potential for accomplishing the same objective by reducing Lake Erie inflows and levels was addressed in the Commission's 1976 Report entitled *Further Regulation of the Great Lakes*.

CHAPTER VI

CONCLUSIONS

The vast surface areas of the Great Lakes, which are equal to half of the contributing land areas, combined with the limited capacity of the outlet rivers, make the Great Lakes the best naturally self-regulating water system in the world, with relatively constant outflow from the system. The long-term fluctuations of the levels of the Great Lakes are due primarily to persistent but irregular and unpredictable precipitation within the Great Lakes Basin. The regular seasonal fluctuations are characterized by higher supplies in the spring and early summer months and lower supplies for the remainder of the year. Short-term fluctuations usually lasting less than a day are due to wind and differences in barometric pressures which together can cause an imbalance in water levels of as much as four metres (twelve feet) along the longitudinal axis of Lake Erie. Superimposed upon these long-term, seasonal and short-term fluctuations are the wind-induced waves which cause most of the structural and erosion damage along the shoreline.

The Commission believes that a better understanding of the natural fluctuation of lake levels is important to those who wish to use the Great Lakes shoreline and such knowledge ought to be a significant element in the consideration of future use of the shoreline. Improved and coordinated programs by responsible federal, state, and local agencies could provide such information to shoreline owners and prospective owners.

Based on the report by the International Lake Erie Regulation Study Board, public hearings and supplementary information from various sources, the Commission concludes that:

1. Limited regulation of Lake Erie could be achieved by control works in or contiguous to the head of the Niagara River by increasing outflows during high water supplies and at other times maintaining flows approximating natural conditions.

2. Limited regulation of Lake Erie would result in that lake's maximum, mean and minimum water levels being lowered and would transmit some of the lowering effect to Lakes Michigan-Huron. This lowering would be due to increased Lake Erie outflow during periods of above average water supplies to the upper Great Lakes.

3. Limited regulation of Lake Erie would bring about some reduction in flood and erosion damages to coastal zone properties on Lake Erie and the upper Great Lakes and increase the recreational beach area. These economic benefits would be more than offset by losses to commercial navigation and recreational boating as well as losses to hydro-electric power interests.

4. Limited regulation of Lake Erie would result in an increase in the frequency of occurrences of high outflows from Lake Ontario.

5. The existing physical dimensions of the St. Lawrence River were not adequate to accommodate the high supplies of water to Lake Ontario in the early 1970's and at the same satisfy all the Commission's criteria and other requirements of the Commission's Order of Approval for the regulation of that Lake. To accommodate the Lake Erie outflows under limited regulation of Lake Erie, and these high supplies, remedial channel enlargements would be necessary in certain reaches of the St. Lawrence River. The costs of channel enlargements in the St. Lawrence River are themselves not economically justified by the benefits that could be provided to Lake Ontario coastal zone interests.

6. Limited regulation of Lake Erie would generally have a net adverse impact on the environment except for certain water quality aspects.

CHAPTER VII

RECOMMENDATIONS

The Commission, after due consideration of all the information, evidence and advice made available to it during the conduct of the enquiry, recommends that:

1. No further or more detailed studies of limited Lake Erie regulation for the purpose of reducing high water levels be considered in view of the adverse impacts and the wide disparity between the costs and benefits of such regulation.

2. The Federal, State and Provincial Governments take further steps to assure that better coastal zone management practices are followed in order to reduce flood and erosion damage along the shoreline of the Great Lakes.

3. Federal, State and Provincial Governments undertake a vigorous information program to bring about a better understanding of the natural phenomena which cause the fluctuations of the levels of the Great Lakes.

Signed this 22nd day of November, 1983, as the International Joint Commission's report to the Governments of the United States and Canada on Limited Regulation of Lake Erie.

J. Blair Seaborn

Robert C. McEwen

E. Richmond Olson

L. Keith Bulen

Charles M. Bédard

Donald L. Totten

Appendix A

TEXT OF REFERENCE TO THE INTERNATIONAL JOINT COMMISSION

On February 21, 1977 the Secretary of State for External Affairs for the Government of Canada, and the Secretary of State for the Government of the United States sent the following Reference to the International Joint Commission, through identical letters addressed respectively to the Canadian and United States Sections of the Commission:

I have the honour to inform you that the Governments of Canada and the United States have agreed, pursuant to Article IX of the Boundary Waters Treaty of 1909, and in light of the first recommendation contained in the International Joint Commission's report of May 7, 1976, entitled "Further Regulation of the Great Lakes", prepared under an October 7, 1964 Reference from Governments, to request the Commission to undertake a study to determine the possibilities for limited regulation of Lake Erie, taking into account the applicable orders of approval of the Commission and the recommendations of the Canada-Quebec study of flow regulation in the Montreal region. In particular, this study should examine into and report upon the effects of such limited regulation with respect to:

(a) Domestic water supply and sanitation;

(b) Navigation;

(c) Water supply for power generation and industrial purposes;

(d) Agriculture;

(e) Shore property, both public and private;

(f) Flood control;

(g) Fish and wildlife, and other environmental aspects;

(h) Public recreation; and

(i) Such other effects and implications which the Commission may deem appropriate and relevant.

The Commission, consistent with the principle of systemic regulation of the Great Lakes, which is endorsed by the two Governments, should consider such effects in light of anticipated impacts throughout the Basin, including the international and Canadian reaches of the St. Lawrence River.

In the event that the Commission should find that new or altered works or other measures examined pursuant to this Reference would be economically and environmentally practicable in light of the above stated considerations, it shall estimate the costs of such works or measures and indicate how the various interests on either side of the boundary would be benefited or adversely affected thereby. The Commission shall likewise consider the need for remedial or compensating works, or non-structural approaches, to protect interests potentially adversely affected by the proposed regulatory works or measures, and the approximate costs thereof. The Commission shall further consider as appropriate how such costs might be apportioned between the two Governments or concerned interests in each country.

In the conduct of its investigation and the preparation of its report, the Commission shall make use of information and technical data heretofore available or which may become available in either country during the course of its investigation. In addition, the Commission shall seek the assistance, as required, of specially qualified personnel in Canada and the United States. The Governments shall make available or, as necessary, seek the appropriation of the funds required to provide the Commission promptly with the resources needed to discharge the obligations under this Reference fully within the specified time period. The Commission shall develop as early as practicable cost projections for the studies under reference for the information of Governments.

The Governments request that the Commission, upon the availability of adequate funding, proceed with these studies as expeditiously as practicable and report to Governments no later than March 1, 1979.

Appendix B

RECOMMENDATIONS OF COMMITTEE ON FLOW REGULATION, MONTREAL REGION

On October 21, 1976 the Committee on Flow Regulation in the Montreal Region after a concentrated two year study submitted a report to the Minister of Environment Canada and the Quebec Minister of Natural Resources. It outlined the avenues to solve the high and low water problems in the Montreal Region. The following is an English translation of the recommendations:

1) That the International Joint Commission and the International St. Lawrence Board of Control be advised of the various studies carried out by the Committee and the recommendations derived from these studies;

That these international agencies become cognizant of the importance, for Quebec, of regulating the waters of Lake Ontario in relation to Ottawa River floods and low water periods in the Montreal Region, such measures necessitating no change to regulation plan 1958-D.

2) That the Ottawa Regulating Committee be expanded to represent the interests of the Quebec Department of Natural Resources, the Ontario Ministry of Natural Resources, Environment Canada, and Transport Canada;

That the terms of reference of this committee be reformulated to integrate the operation of all major regulatory works in the Ottawa Basin, taking into account flood and low water problems in the Montreal Region;

That the results of Ottawa River flow regulation studies carried out under the present terms of reference, such as the forecasting model developed by the Committee, be used to optimize the daily operation of the various reservoirs in the Ottawa Basin;

That the measuring instruments required for the proper use of the forecasting model be installed.

3) That the Ottawa Regulating Committee maintain a constant liaison with the International St. Lawrence Board of Control to apply recommendation 1);

That this same committee ensure that the advantages of changing the regime of the Ottawa River be applied primarily to the Montreal Region and the municipalities along the Ottawa.

4) That the studies necessary to carry out the works required to increase the live storage capacity of the Des Quinze reservoir in the Ottawa Basin be completed;

That the increased storage capacity be used for flood control and low water support purposes, primarily for the Montreal Region.

5) That the power production and flood control benefits to be drawn from the construction of new reservoirs on the Dumoine and Coulonge Rivers be studied in cooperation with Hydro Quebec.

6) That the studies preliminary to the installation of control works at the outlet of Lake of Two Mountains into the Mille Iles River designed to keep the flow of this river below 25,000 cubic feet per second (cfs) as much as possible be completed.

7) That the possibility of building dikes or implementing other adequate measures to reduce flood damages be studied in cooperation with the authorized representatives of the towns around Lake of Two Mountains and Lake Saint-Louis and along the Des Prairies River (the implementation of these protection measures must be supported by a favourable cost-benefit analysis).

8) The flood-risk mapping program be completed for the entire Montreal Region.

9) That the municipalities in the Montreal Region be strongly urged to make allowance for designated flood-risk areas in their master development plans;

That these areas, as identified in the mapping program, be subject to measures limiting development;

That a special group made up of representatives from the Quebec Department of Municipal Affairs and the Department of Natural Resources be set up to advise municipalities with regard to the implications of flood control on urban development planning.

10) That the possibility of establishing an assistance program for individual floods (e.g. raising buildings, relocating, etc..) be studied.

11) That the ice-cover and break-up monitoring program on the Des Prairies River be continued;

That the ice booms planned by Hydro Quebec at Paton Island and Sainte-Geneviève on the Des Prairies River be installed;

That the steps be taken to systematically destroy any ice-jam capable of causing damages.

12) That an implementation agreement be signed between the Government of Canada and the Government of Quebec to concretize the recommendations of the Committee on Flow Regulation, Montreal Region;

That this agreement make provision for the formation of an implementation committee responsible for following through with the recommendations of the Committee on Flow Regulation, Montreal Region.

APPENDIX C

MEMBERSHIP OF THE INTERNATIONAL LAKE ERIE REGULATION STUDY BOARD AND ITS COMMITTEES

The International Joint Commission established the International Lake Erie Regulation Study Board on May 3, 1977. When the Board submitted its report to the Commission dated July 1981, the membership of the Board consisted of the following:

INTERNATIONAL LAKE ERIE REGULATION STUDY BOARD

United States Section

Brigadier General Scott B. Smith, U.S. Army Corps of Engineers, Chairman
Wayne S. Nichols, Ohio Department of Energy
David F. Riley, U.S. Fish and Wildlife Service
Robert A. Cook, New York Department of Environmental Conservation
Chris P. Potos, U.S. Environmental Protection Agency
Donald J. Leonard, U.S. Army Corps of Engineers, Secretary

Canadian Section

Derek M. Foulds, Department of the Environment, Chairman
Roy A. Walker, Ontario Hydro
Fernand Santerre, Hydro Quebec
J.E. Bryant, Department of the Environment
V.J.M. Johns, Department of the Environment, Secretary

FORMER BOARD MEMBERS

United States	Canada
Major General Richard L. Harris, Chairman	R. Beauchemin, Secretary
Colonel Andrew C. Remson Jr. Acting Chairman	
Major General Robert L. Moore, Chairman	
W.T. Olds Jr.	
Terence P. Curran	

As authorized by the Commission, the Board established a number of Committees and Subcommittees. When the Board submitted its report, the Committees and members were listed as follows:

INTERNATIONAL LAKE ERIE REGULATION STUDY WORKING COMMITTTEE

United States	Canada
Colonel George P. Johnson U.S. Army Corps of Engineers Chairman	Albert R. LeFeuvre Department of the Environment Chairman
Charles H. Carter, Ohio Department of Natural Resources	John M. Spratt, Ontario Hydro
Allan C. Tedrow, New York Department of Environmental Conservation	Jean-Claude Rassam, Quebec Hydro Electric Commission
Alvin Hollmer, Power Authority of the State of New York	Gary B. McCullough, Canadian Wildlife Service
Deiter N. Busch, U.S. Fish and Wildlife Service	Dave L. Strelchuck, Ministry of Natural Resources
Anthony J. Eberhardt, U.S. Army Corps of Engineers	Peter P. Yee, Department of the Environment

FORMER COMMITTEE MEMBERS

United States	Canada
Colonel Daniel D. Ludwig, U.S. Army Corps of Engineers	Ray Beauchemin, Department of the Environment
Charles Kulp, U.S. Fish and Wildlife Service	Nicholas Persoage, Department of the Environment
Charles L. Baldi, U.S. Army Corps of Engineers	Robert Brisebois, Quebec Hydro Electric Commission

INTERNATIONAL LAKE ERIE REGULATION STUDY COMMITTEES

REGULATION

United States	Canada
B.G. DeCooke,U.S. Army Corps of Engineers, Chairman	D.F. Witherspoon, Canadian Department of Environment, Chairman
W.P. Erdle, U.S. Army Corps of Engineers	P.P. Yee, Canadian Department of Environment

REGULATORY WORKS

United States	Canada
J.A. Foley, U.S. Corps of Engineers, Chairman	D.R. Cuthbert, Canadian Department of Environment, Chairman
S. Daly, U.S. Army Corps Engineers	A. Ellis, Canadian Department of Environment
J.N. Erhart, U.S. Army Corps of Engineers	J.A. McGregor, Ontario Hydro
A. Hollmer, Power Authority of State of New York	P.P. Yee, Canadian Department of Environment
S. Hung, St. Lawrence Seaway Development Corp.	
A.C. Tedrow, NYS Department of Environmental Conservation	

COASTAL ZONE

United States	Canada
M.J. Todd, U.S. Army Corps of Engineers, Chairman	R.J. Moulton, Canadian Department of Environment Chairman
C. Baghelai, U.S. Army Corps of Engineers	D. Brown, Canadian Department of Environment
P. Borek, Great Lakes Basin Commission	A. Carpentier, Environment Quebec
R. Clemens, Great Lakes Basin Commission	W. Haras, Canadian Department of Fisheries and Oceans
R. Irvin, NYS - Coastal Management Citizen's Advisory Committee	T. Kolberg, Canadian Department of Public Works
M. Isoe, U.S. Army Corps of Engineers	J.Y. Pelletier, Canadian Department of Environment
J. Kangas, U.S. Army Corps of Engineers	D. Strelchuk, Ontario Ministry of Natural Resources
J. Kotas, Great Lakes Basin Commission	C. Worte, Canadian Department of Environment
T. Pieczynski, U.S. Army Corps of Engineers	

NAVIGATION

United States	Canada
C. Larsen, U.S. Army Corps of Engineers, Chairman	C. Lawrie, Canadian Ministry of Transport, Chairman
R. Lewis, St. Lawrence Seaway Development Corp.	G.R. Golding, Canadian Ministry of Transport
S.R. Heckman, U.S. Army Corps of Engineers	N. Mangione, Canadian Department of Public Works
R. McIntyre, U.S. Army Corps of Engineers	

POWER

United States	Canada
A. Hollmer, Power Authority of State of New York, Chairman	J.M. Spratt, Ontario Hydro, Chairman J.C. Rassam, Hydro Quebec Electric Commission R. Brisebois, Hydro Quebec Electric Commission

ENVIRONMENTAL EFFECTS (Water Quality, Fish, Wildlife, and Recreational Beaches and Boating)

United States	Canada
D.N. Busch, U.S. Fish and Wildlife Service, Chairman	J.T. Urisk, Canadian Department of Environment, Chairman
E. Angle, Ohio Department of Natural Resources	C. Cheng, Canadian Department of Environment
D.F. Brown, U.S. Fish and Wildlife Service	T. Beaulieu, Canadian Department of Fisheries and Oceans
J. Brown, U.S. Army Corps of Engineers	P. Bewick, Ontario Ministry of Natural Resources
J. Collis, U.S. Army Corps of Engineers	W. Bien, Canadian Department of Environment
L. Emery, U.S. Fish and Wildlife Service	T. Burton, Ontario Ministry of Natural Resources
P. Frapwell, U.S. Army Corps of Engineers	D. Gillespie, Canadian Department of Environment
R.J. Guido, U.S. Army Corps of Engineers	A. Holder, Ontario Ministry of Natural Resources
R. Haas, Michigan Department of Natural Resources	R. Hore, Ontario Ministry of Environment
R. Kenyon, Pennsylvania Fish Commission	H. Johnson, Canadian Sea Lamprey Control Centre
C. Kulp, U.S. Fish and Wildlife Service	E. Krakowski, Canadian Department of Environment
E. Megerian, U.S. Army Corps of Engineers	M. Marshall, Ontario Ministry of Natural Resources
R. Oberst, U.S. Fish and Wildlife Service	G. McCullough, Canadian Department of Environment
W. Pearce, NYS Department of Environmental Conservation	J. Tibbles, Canadian Sea Lamprey Control Centre
C.P. Potos, U.S. Environmental Protection Agency	
R. Scholl, Ohio Department of Natural Resources	
W. Shepherd, NYS Department of Environment Conservation	
T. Vogel, Ohio Department of Natural Resources	
B. Williamson, U.S. Army Corps of Engineers	

AD HOC ECONOMICS

United States	Canada
R. Guido, U.S. Army Corps of Engineers	T. Muir, Canadian Department of Environment

AD HOC PUBLIC INFORMATION

United States	Canada
A.J. Eberhardt, U.S. Army Corps of Engineers	P.P. Yee, Canadian Department of Environment
H.R. Fredenburg, U.S. Army Corps of Engineers	J. Lloyd, Canadian Department of Environment

J. Hall, Consultant
E. McGuinness, Consultant

APPENDIX D

PERSONS PRESENTING BRIEFS OR TESTIMONY AT IJC PUBLIC HEARINGS

1977 HEARINGS

November 15, 1977 at Chateauguay, Quebec

P. Bonneau, Mayor, Chateauguay, Quebec
B. Harvey, Ministry of Natural Resources, Province of Quebec
Ian Watson, Federal M.P. for Lagrairie-Chateauguay
L. Savage, Comites de Citoyens de la Region deux Montagnes
J.M. Kane, Caughnawaga, Quebec
J. Dion, Caughnawaga, Quebec
R. Lepage, Hydro Quebec
G. Provencher, Ligue d'action Civique, Chateauguay

November 16, 1977 at Chicago, Illinois

J. Lieberman for Congressman Abner Mikva
N.R. Fulton, Assistant City Manager, Elmhurst, Illinois
R.H. VanDeusen, Glenview, Illinois
J. Stinson, Chicago, Illinois
J. Corey, Department of Water and Sewers, Chicago, Illinois
R. Glaman, Milwaukee County, Wisconsin
P. Wise for Don Vonnahme, Assistant Director of the Illinois Water Resources
J. Smedile, Northeastern Illinois Planning Commission

November 17, 1977 at Peoria, Illinois

R. Watson, City Clerk, Eureka, Illinois
H.F. Stenstrom, Chillicothe, Illinois
M. Bryant, Illinois River Valley Residents Association, Chillicothe, Illinois
J. Marlin, Coalition on American Rivers, Champaign, Illinois
D.G. Meinen, Tri-County Regional Planning Commission, East Peoria, Illinois
M. McClure, Illinois Valley Flood Control Association, Beardstown, Illinois
L.A. Johnson, Peoria County Board, Bartonville, Illinois
G. Jackson, Peoria, Illinois
G. Maher, Dunlap, Illinois

L. Podell, Peoria, Illinois
J. Zeigler, Peoria, Illinois
L.K. Jackson, Heart of Illinois Sierra Club, Peoria, Illinois
F. DeBruna, Director of Water Resources, Springfield, Illinois
W.J. Dwyer, Chillicothe, Illinois

December 5, 1977, at Cleveland, Ohio

No formal presentations

December 6, 1977, at Buffalo, New York

B. Wicks, Hamburg Town Council
R.P. Griffin, Erie-Niagara Regional Planning Board
J.J. MacDonald, Commissioner Public Works, Buffalo
J.E. Carr, Urban Waterfront Advisory Committee
A.T. Voell, Erie County Department of Environment and Planning
W.M. Friedman, New York State Department of Environmental Conservation
R.D. Conner, Power Authority of the State of New York

December 7, 1977, at Windsor, Ontario

R. Trombley, Macomb County Board of Commissioners

December 8, 1977, at Toronto, Ontario

M. McLaughlin, Ontario Sailing Association
I. Ramsay, Ontario Ministry of the Environment
S.B. Panting, Ontario Ministry of Natural Resources
J.B. Bryce, Ontario Hydro
P.W. Acres, Shoreland Preservation Association of Ontario

1982 HEARINGS

November 17, 1982, at Cleveland, Ohio

G.C. Petry, North Bass Island, Ohio
H. Fitzgerald, Cleveland, Ohio
Peter Frank, Lake, Bay Association, Webster, New York
William Lorimer, Perry, Ohio
M.T. Scanlon, Cedar Point Homeowner's Association, Sandusky, Ohio
B. Romano, Madison, Ohio
D. Angel, Citizens for Land and Water Use, Cleveland, Ohio

R. Knox, Ohio
R. Marts, Department of Natural Resources,
State of Ohio

November 18, 1982, at Niagara Falls, Ontario

Peter Frank, Lake, Bay Association, Webster, New York
T. Jeacock, Canadian Sportsmen's Club,
Fort Erie, Ontario
D. Rehmann, Erie County Shoreline Task Force,
Blasdell, New York
T. Deaving, for County Executive Edward Rutkowski,
Erie County, New York
G. Hutton, Fort Erie, Ontario

November 19, 1982, at Odensburg, New York

General discussion with no formal testimony.

END

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